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PATENT SPECIFICATION (11) 1396301

1396301

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(72) Inventor KEITH EWING

(19)

(54) HIGHWAY CRASH BARRIERS

(71) We, THE BRITISH ALUMINIUM COMPANY LIMITED, a Company registered under the laws of Great Britain, of Norfolk House, St. James's Square, London, S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to highway crash barriers, particularly but not exclusively to parapets for edges of bridges or high level roadways and to such parapets in combination with roadside safety fences.

One aspect of the invention provides a barrier comprising a plurality of spaced upright posts anchored at their bases, at least two vertically spaced substantially rigid rails each supported by and connected to all the posts and at least one unit incorporated in the barrier such unit having a resistance to longitudinal load considerably in excess of the resistance of any of the posts and comprising a pair of uprights anchored at their bases and spaced closer than the spacing of the posts and being connected together by at least one structural member different from the rails so as to provide a cantilever anchorage.

Preferably the barrier comprises a plurality of units at intervals along its length.

The posts may be arranged to break under transverse loads well before the rails break. Preferably the posts are arranged to break under a transverse load not more than 20% greater than the minimum transverse load which the posts are specified to resist.

In a preferred embodiment the uprights of each unit are connected by a shear panel or panels secured both to the uprights and to horizontal load members. Such a shear panel should extend at least between the top rail and the next adjacent rail and in a barrier with three rails a shear panel will preferably also extend between the middle and lower rails. A small shear panel may also extend between the lower rail and the ground.

The invention further provides a highway crash barrier comprising in combination a bridge parapet and a roadside safety fence, the parapet being in the form of a barrier in accordance with any of the preceding five paragraphs with the units disposed at one end thereof.

It is preferred that the width to height ratio of the or each load resisting unit is between $\frac{1}{4}$:1 and 2:1 and with advantage is between $\frac{1}{2}$:1 and 1:1.

Three embodiments of barrier, in accordance with the invention, will now be described by way of example only with reference to the accompanying drawings of which:

Figure 1 is a diagrammatic front view of part of a parapet;

Figure 2 is a diagrammatic view on the line II—II of Figure 1 on an enlarged scale;

Figure 3 is a section on the line III—III of Figure 1 on an enlarged scale;

Figure 4 is a perspective view of the back of an alternative form of parapet;

Figure 5 is a diagrammatic front view of one end of a parapet connected to one end of a safety fence;

Figure 6 is a view on an enlarged scale of part of Figure 5, and

Figure 7 is a view in the direction of arrow VII of Figure 6.

Referring to Figures 1 to 3, the barrier comprises a plurality of spaced upright posts 12 and three substantially horizontally extending spaced parallel rails 13, 14 and 15 connected to, supported by and extending between all the posts. Although not shown as such in the drawings each post 12 is made from two aluminium extrusions welded together so that it is hollow, of substantially rectangular section and tapers towards its upper end which is closed by a cap 16. Each such hollow section has its base welded to an aluminium base casting 17 having an upright portion 18 extending for a small distance into the hollow base of the post and having a foot portion 20 anchored by bolts 21 to a concrete foundation 22. As seen most clearly in Figures 2 and 4 the front surface of each post is extended by a flange 23 at

each side, these flanges being used for securing the rails to the posts by bolts or other fixings. Each of the rails 13, 14 and 15 (Fig 3) is formed as an aluminium extrusion defining on its rear face a pair of continuous recesses 26 opening to the rear face through slots 27 of smaller cross section than the recesses 26 so that the recesses are undercut relative to the slots. The recesses 26 accommodate the heads 28 of bolts 30, the shanks of which pass through the slots 27 and the flanges 23 and receive washers and nuts 31.

For parapets the Ministry of Transport lays down specifications which include the minimum transverse loads which the posts must withstand without breaking. While these specifications may be made in dynamic terms they are usually equated with static conditions for test purposes. For example, the specification requires that a post designated a P1 post must be able to withstand a static transverse load of five tons applied to the post 2 ft. 3ins. from the ground. A P1 post in the examples of this specification is arranged to break under such an applied load of between 5 and 7 tons and preferably between 5.3 and 5.8 tons. In general the posts of the barriers according to a preferred form of this invention will break under a transverse load not more than 20% greater than that specified.

The posts described will break where the posts are welded to their base castings without causing much damage to the posts or the securement of the castings to the ground. When one or more posts break the rails will be deflected inwardly in the form of a catenary and longitudinal loads will be applied through the rails to those posts adjacent the break. In order to strengthen the barrier against longitudinal loads the barrier is provided at intervals with load resisting units. Such load resisting units are provided at each end of the barrier and may be at spaced intervals along its length. For example in a barrier where the posts are 4 ft. high and are spaced at intervals of 10 ft. to 12ft. 6 ins. a load resisting unit will be incorporated each 70 to 200 ft. and preferably about each 150 ft.

Each load resisting unit in the embodiment described is formed by a pair of uprights 12 spaced closer together than the posts of the remainder of the barrier and connected together by structural members in the form of shear panels 32. In the example shown two shear panels are provided, one extending between the upper and middle rails and the other extending between the middle and lower rails. A further shear panel could be provided between the lower rail and ground with its lower edge firmly embedded in the ground. These shear panels are bolted along all their four sides respectively to the posts and the rails. It is essential that the upper and lower edges of the shear panels are contained by end load members and these are conveniently formed by the rails but clearly separate end load members could be provided if required. The shear panels are inserted between the rails and the front faces of the uprights, but provided they are in the plane of the barrier they could alternatively be secured to the back faces of the uprights or the front faces of the rails. Such a unit is of framed cantilever form, anchored at its base to the ground and resisting loads applied by tension in the rails. It will have a stiffness equivalent to many posts.

By way of example the minimum moment of inertia (the property affecting resistance to bending of an upright in the longitudinal plane) thereof is approximately 5.67 $in.^4$. If an end anchor consists solely of two such uprights, then the inertia available against longitudinal bending $=2\times5.67=11.34$ in^4. Now by placing a shear panel between these two uprights and providing top and bottom boundary members to the panels (existing rails) and fixing the panel adequately to the uprights and the rails, the resistance to stiffness is dependent on the product of the upright area and the square of half the distance between the uprights ($I=2Ay^2$). Now the upright area $=3.83$ in^2 and for a 36 in. high parapet, the uprights could be spaced between 18 in. and 36 in. apart.

$$\text{At 18 in. } 2Ay^2=2\times3.83\times\left(\frac{18}{2}\right)^2=620 \text{ in}^4$$

$$\text{At 36 in. } 2Ay^2=2\times3.83\times\left(\frac{36}{2}\right)^2=2490 \text{ in}^4$$

We have assumed in this calculation that the shear panel extends from the top of the parapet to ground level which may not always be the case. If the shear panel does not extend down to the ground line then some loss in stiffness will result but since the increase in stiffness by providing the shear panel is so great a considerable reduction in the possible full depth value is acceptable.

Another embodiment of parapet is shown in Figure 4 where the upper and middle rails 13A and 14A are of steel and are of a more open construction than the aluminium rails of Figures 1 to 3. This open construction allows access to the hollow interior of the rails so that bolts can be inserted through the flanges 33 on their rear sides for bolting them to the flanges 23 of the posts and to the shear panels 32. The lower rail 15A is of aluminium corresponding to the rail 15 of the embodiment of Figures 1 to 3. The shear panels 32 again are of similar construction to those of the arrangement of Figures 1 to 3.

The embodiment of Figures 5 to 7 shows a parapet in combination with a tensioned roadside safety fence. In this arrangement the load resisting unit at the end of the parapet is firmly connected to the tensioned safety fence so that longitudinal strains in the safety fence are taken up by the load resisting unit which avoids the necessity for the conventional separate anchorage for the safety fence. The parapet may be similar to that shown in Figures 1 to 3 or may have a load resisting unit only at its end. The tensioned safety fence 34 comprises a tensioned guard rail 35 supported on a plurality of spaced posts 36 and incorporating tensioning devices, one of which is seen at 37, at eighty yard intervals. The end of the guard rail 35 adjacent the end of the parapet is secured via a transition piece 38 to one end of a box beam 40. The load resisting unit at the end of the parapet comprises a pair of uprights 12, spaced more closely than the ordinary posts of the parapet, with a shear plate 41 extending between them. In this case the shear plate extends from above the centre rail 14 to adjacent the feet of the uprights and its lower edge is turned outwardly through 90° to provide a forwardly projecting flange 42 forming a lower end load member. The box beam 40 also extends between these two posts 12 and for the whole of its length extending between the two uprights has upper and lower flanges 43, 44 welded to its back edges 45. These flanges project beyond the upper and lower sides of the beam and serve for bolting the beam both to the uprights and at intervals across the distance between the uprights to the shear panel. The box beam thus serves as an upper end load member for the shear panel. The box beam is of considerably greater section than the central rail 14 and extends over this rail to completely cover it. The lower parts of the sides of the shear plate 41 are bolted to the uprights 12 by clamp plates 46.

Any impact tensions in the safety fence will be transmitted through the safety fence into the shear panel structure and hence via the parapet into the ground.

The width to height ratio of each cantilever unit is preferably in the range between $\frac{1}{4}$:1 and 2:1 and with advantage between $\frac{1}{2}$:1 and 1:1. This will ensure that stiffness of the cantilever unit is the equivalent of at least 20 individual post stiffnesses.

The parapet could be formed with only two rails or might have more than three.

The load resisting cantilever unit could be made up by using other structural members having in known manner the same effect as the shear panels, for example a diagonal bracing member or members such as a strut and/or stay to provide a triangulated framework.

WHAT WE CLAIM IS:—

1. A barrier comprising a plurality of spaced upright posts anchored at their bases, at least two vertically spaced substantially rigid rails each supported by and connected to all the posts and at least one unit incorporated in the barrier such unit having a resistance to longitudinal load considerably in excess of the resistance of any of the posts and comprising a pair of uprights anchored at their bases and spaced closer than the spacing of the posts and being connected together by at least one structural member different from the rails so as to provide a cantilever anchorage.

2. A barrier according to claim 1 comprising a plurality of units at intervals along its length.

3. A barrier according to claim 1 or claim 2 in which the posts are arranged to break under transverse loads before the rails break.

4. A barrier according to any one of the preceding claims in which the posts are arranged to break under a transverse load not more than 20% greater than the minimum transverse load which the posts are specified to resist.

5. A barrier according to any one of claims 1 to 4 in which the width to height ratio of each load resisting unit is between $\frac{1}{4}$:1 and 2:1.

6. A barrier according to claim 5 in which the width to height ratio is between $\frac{1}{2}$:1 and 1:1.

7. A barrier according to any one of the preceding claims including a load resisting unit each 70 to 200 feet along its length.

8. A barrier according to any one of claims 1 to 7 in which the uprights of each unit are connected by a shear panel or panels secured both to the uprights and to horizontal end load members.

9. A barrier according to claim 8 in which the end load members are formed by the rails.

10. A barrier according to claim 8 or claim 9 in which the shear panels are located between the backs of the rails and the front faces of the uprights.

11. A barrier according to any one of claims 1 to 10 in combination with a safety fence, one end of the safety fence being fixed to a load resisting unit at the end of the barrier so that tensions in the safety fence are transmitted to that load resisting unit.

12. A highway crash barrier comprising in combination a bridge parapet and a roadside safety fence, the parapet being in the form of a barrier according to any one of claims 1 to 10 with the unit disposed at one end thereof.

13. A highway crash barrier according to claim 12 when appendant to claim 8 including a beam connected to the safety fence and secured both to the uprights and the shear panel of the unit.

14. A highway crash barrier according to claim 13 in which the beam forms an end load

member secured along one edge of the shear panel.

15. A highway crash barrier according to claim 13 in which one edge of the shear panel is provided with a flange extending out of the plane of the shear panel to form an end load member.

16. A highway crash barrier according to any one of claims 12 to 15 in which the fence is a tensioned safety fence.

17. A barrier according to any one of the preceding claims in which the posts are of aluminium or aluminium alloy and the rails are of aluminium, aluminium alloy or steel.

18. A barrier substantially as described herein with reference to Figures 1 to 3, Figure 4 or Figures 5 to 7 of the accompanying drawings.

For the Applicants:
RAWORTH MOSS & COOK,
Chartered Patent Agents,
36, Sydenham Road,
Croydon,
Surrey,
and
75, Victoria Street,
Westminster,
London, S.W.1.

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Sheet 1

FIG. 1.

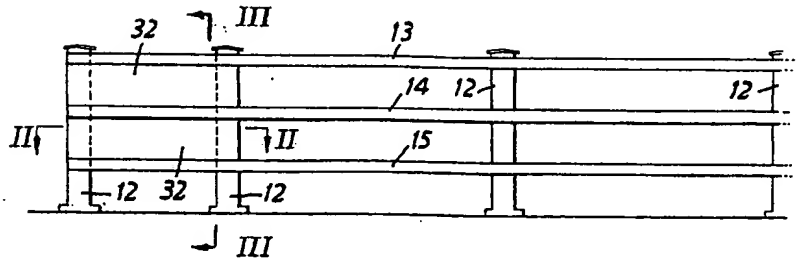


FIG. 2.

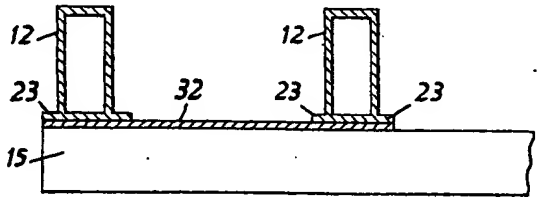


FIG. 4.

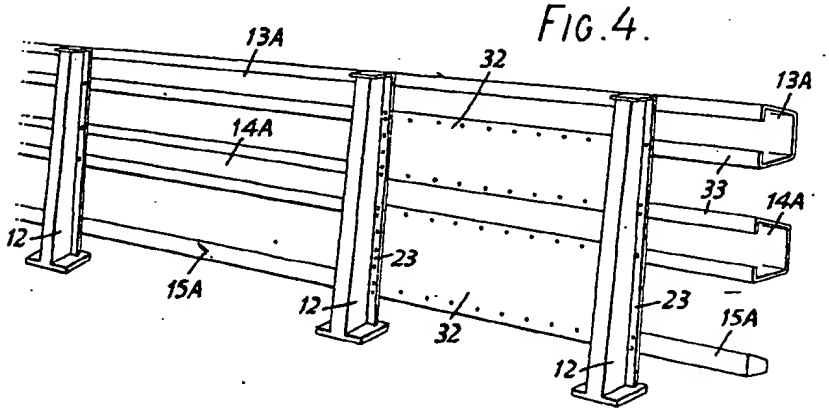
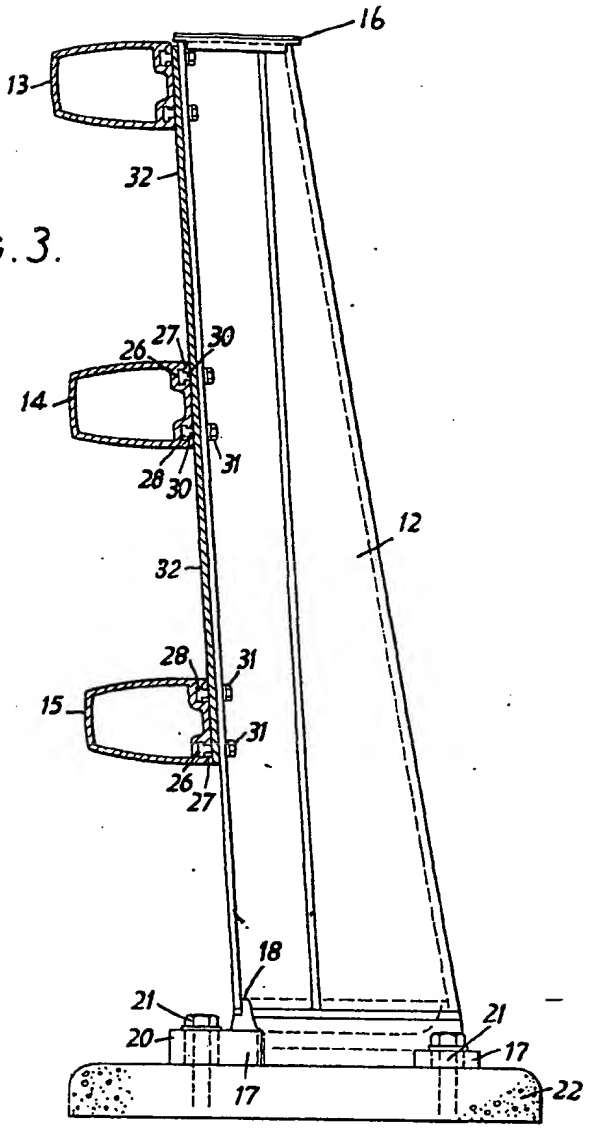


FIG. 3.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Sheet 3

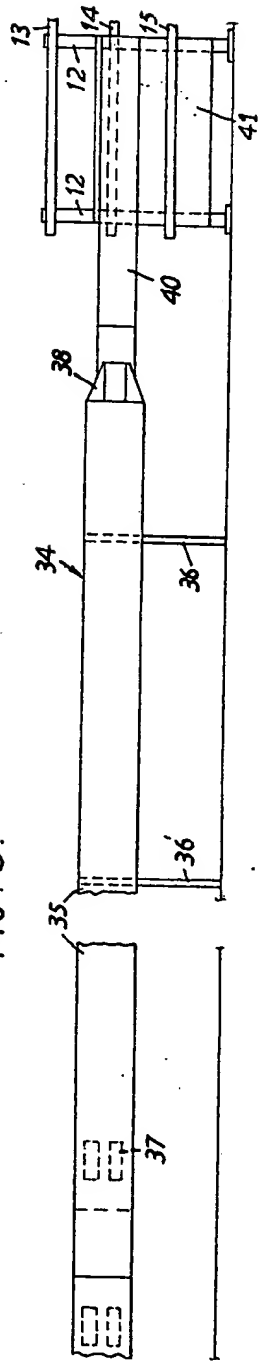

FIG. 5.

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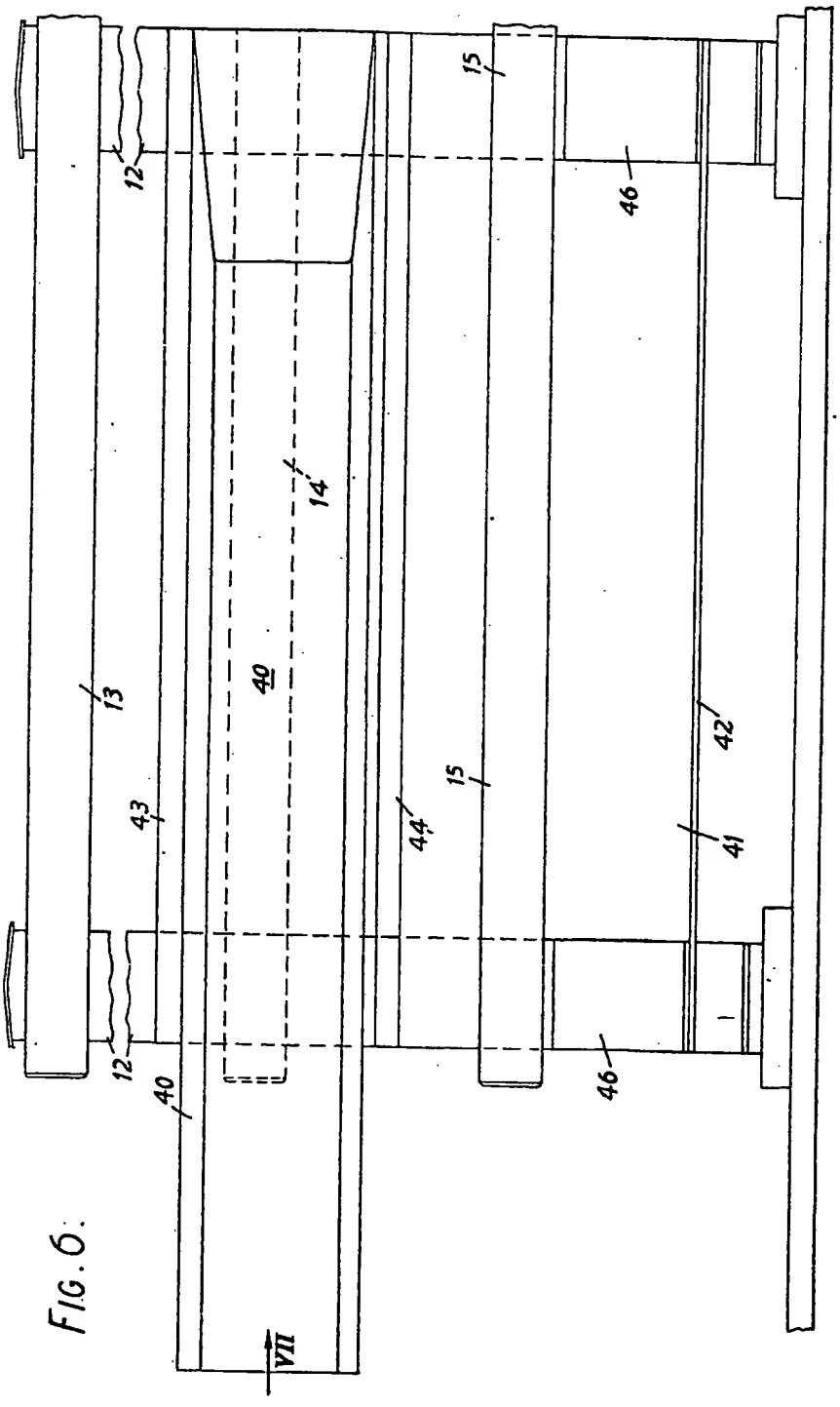

FIG. 6.

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FIG. 7.